WW: DY Estimation, Met Efficiency and JEC in 38X data/MC

Outline

- List of datasets
- DY estimation for WW
- MET selection efficiencies in WW
- Jet response in 38X data/MC using the Z+1 jet events

Datasets

- Data
  - 15/pb data corresponds to: /afs/cern.ch/user/s/slava77/public/jsons/oct22/special/Cert_TopOct22_Merged_135821-148058_allPVT.txt
- 38X MC for DY estimation and JEC studies
  - /DYToEE_M-20_TuneZ2_7TeV-pythia6_Fall10-START38_V12-v1/
  - /DYToMuMu_M-20_TuneZ2_7TeV-pythia6_Fall10-START38_V12-v1/
- 36X MC for Met efficiency comparisons
  - Pythia: /WWTo2L2Nu_7TeV-pythia6_Spring10-START3X_V26-v1
  - Madgraph: /VVJets-madgraph_Spring10-START3X_V26_S09-v1
  - MC@NLO: /WWtoEE-mcatnlo_Spring10-START3X_V26_S09-v1

DY Estimation

Drell Yan Estimation (1/2)

- Data driven method to predict DY in EE/MM (AN-2009/023)
  - Use the events inside the Z window to predict the value outside
  - The ratio Rout/in are obtained through MC

$$\boxed{N_{DY}^{out\ (est)} = \frac{N_{DY\ DATA}^{in}}{N_{DY\ MC}^{in}} \cdot N_{DY\ MC}^{out}} \rightarrow \boxed{N_{DY}^{out\ (est)} = N_{DY\ DATA}^{in} \cdot R_{out/in}}$$

  - Use the EM yields to predict the non-peaking background

$$N_{DY/ZZ}^{out\ (est)} = (N_{ll\ DATA}^{in} - k \cdot N_{e\mu\ DATA}^{in}) \cdot R_{out/in}$$

- Test on the events without MET, see good agreement

Table 2: Drell-Yan estimation with no MET Cut.

Sample	ee	$\mu\mu$
$R_{out/in}$	0.09 ± 0.00	0.10 ± 0.00
MC Prediction	278.58 ± 1.71	425.79 ± 2.06
Data Driven DY Estimate	295.63 ± 5.56	481.32 ± 7.37
Actual Yield in Data	316	491

Drell Yan Estimation (2/2)

- Rout/in is sensitive to the projected MET cut
  - Events with large projected MET are statistically limited
- Before we can get a large DY MC, take the conservative approach: use the largest spread of the Rout/in as the systematic error

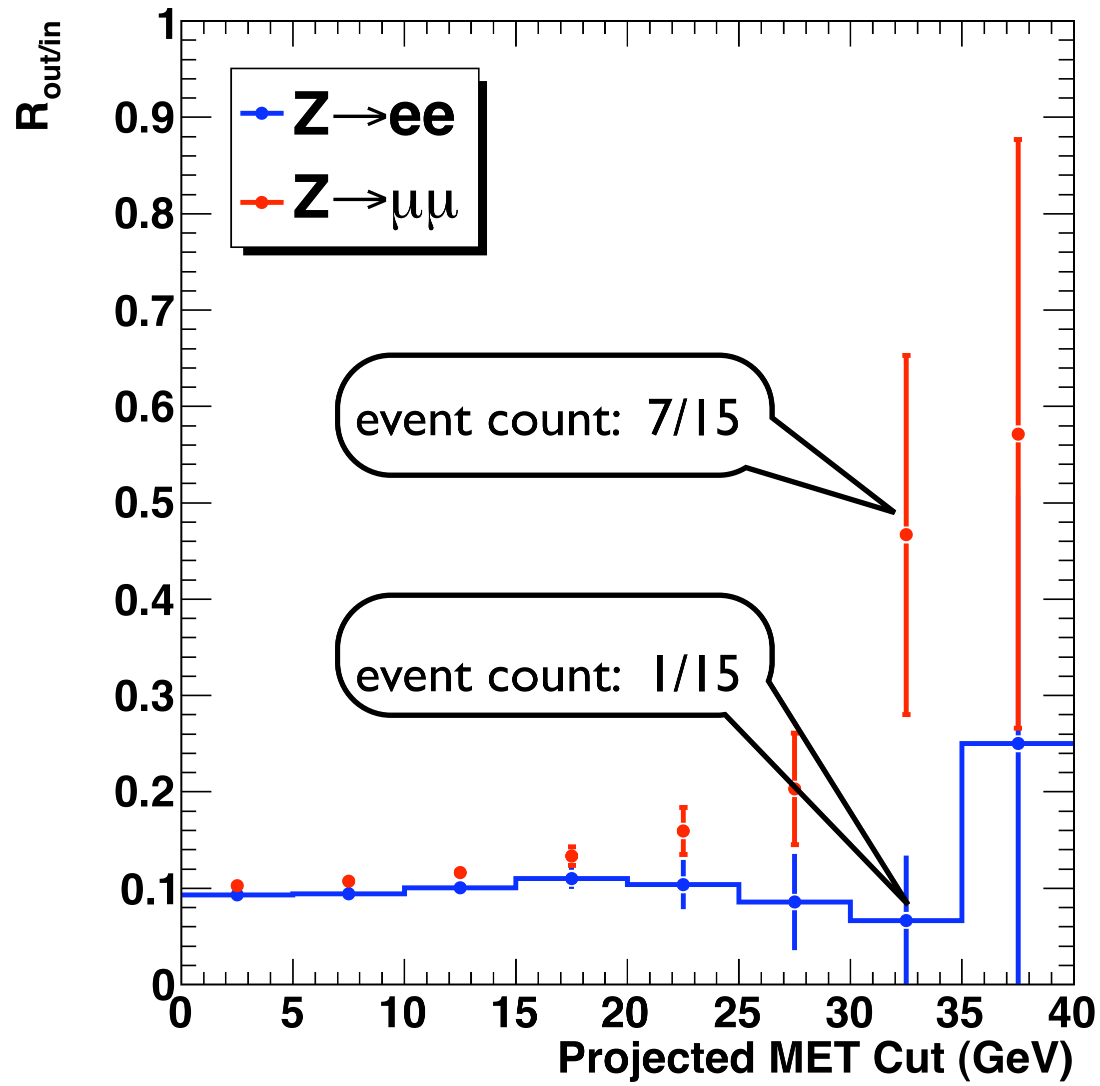
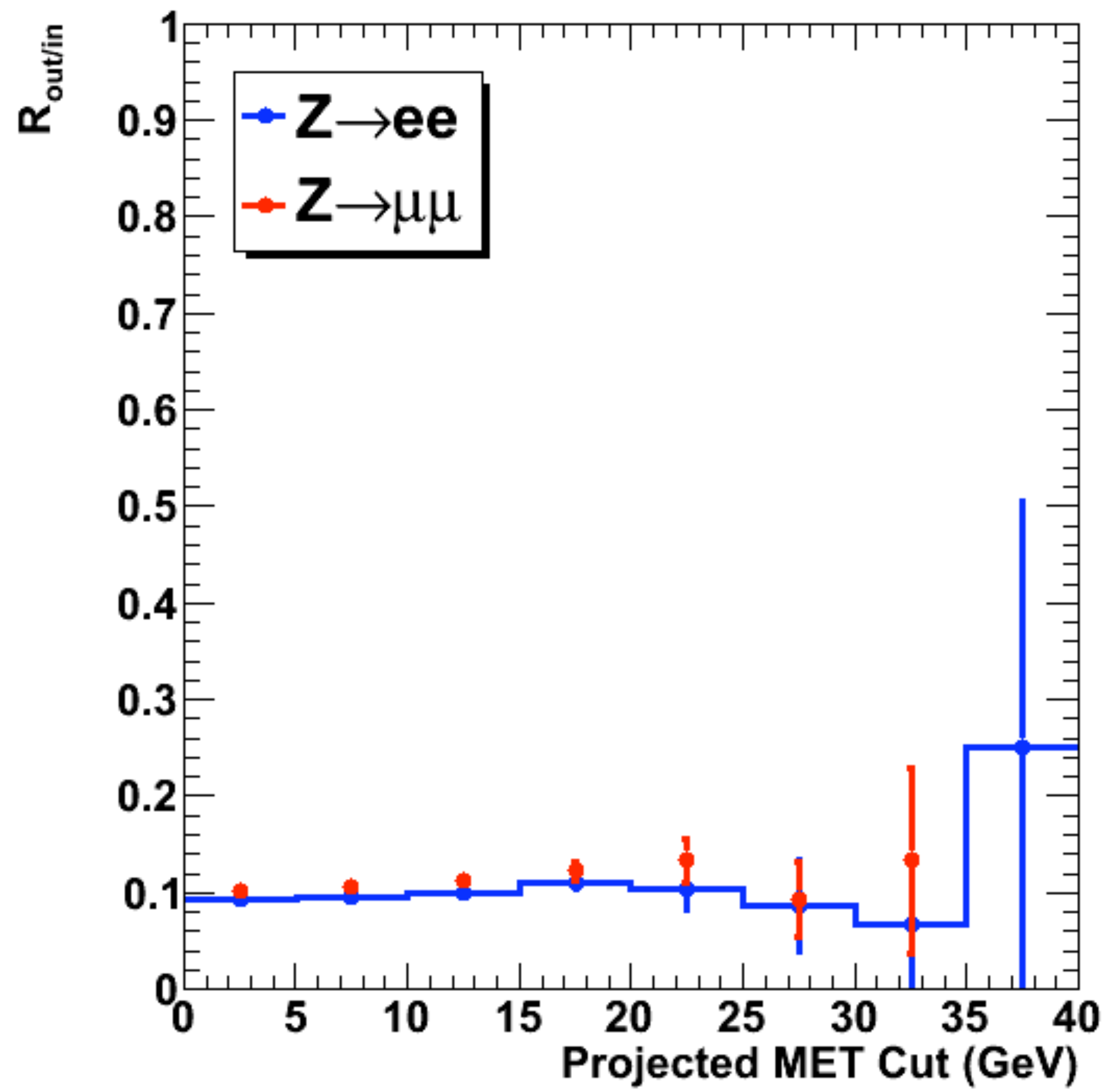


Table 1: Drell-Yan estimation with the nominal MET Cut.

Sample	ee	$\mu\mu$
$R_{out/in}$	$0.07 \pm 0.07 \pm 0.04$	$0.47 \pm 0.18 \pm 0.36$
MC Prediction	0.01 ± 0.01	0.07 ± 0.03
Data Driven DY Estimate	$-0.03 \pm 0.04 \pm 0.03$	$0.18 \pm 0.55 \pm 0.57$
Actual Yield in Data	0	0

Investigation on the DY MM

- We check the 7 events passing ww selections, and see that 5 events contain muons with large σpT, such as 116.2±50.0, 80.5±10.0
- Selecting muons with additional σpT/pT < 0.1 gets rid of the bad behavior in the Rout/in ratio
  - Badly measured muons can easily push out the events outside the Z window (+/- 15 GeV)



DY estimate with σpT cut →

Sample	ee	$\mu\mu$
$R_{out/in}$	$0.07 \pm 0.07 \pm 0.04$	$0.13 \pm 0.09 \pm 0.04$
MC Prediction	0.02 ± 0.02	0.02 ± 0.01
Data Driven DY Estimate	$-0.03 \pm 0.04 \pm 0.03$	$0.05 \pm 0.16 \pm 0.16$
Actual Yield in Data	0	0

Signal/Background Check on cut $\sigma pT/pT < 0.1$

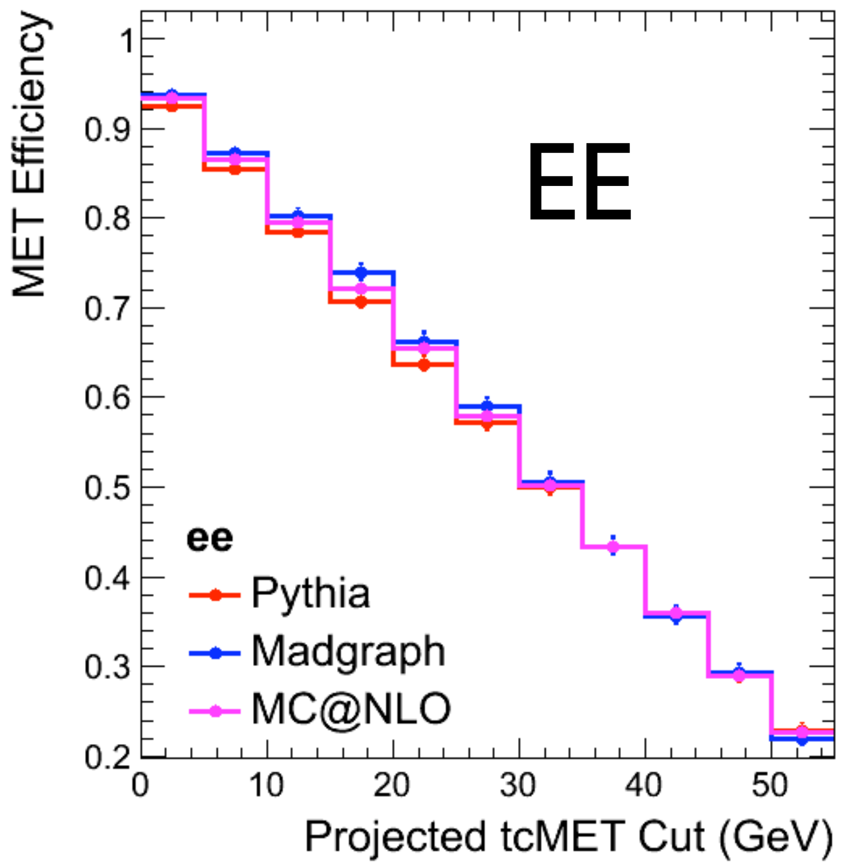
- With 36X MC
  - WW efficiency drops by 0.5%
  - Z(MM) MC background in MM channel is removed completely
    - The 100/pb estimation reduces from 0.14±0.10 (2 events) to 0.
- With 38X MC (Note that the cuts are not synced to v1)
  - Z(MM) MC background in MM channel reduces by more than one half
    - 7 events reduces to 2 events
- We propose to add this cut to the reference V1

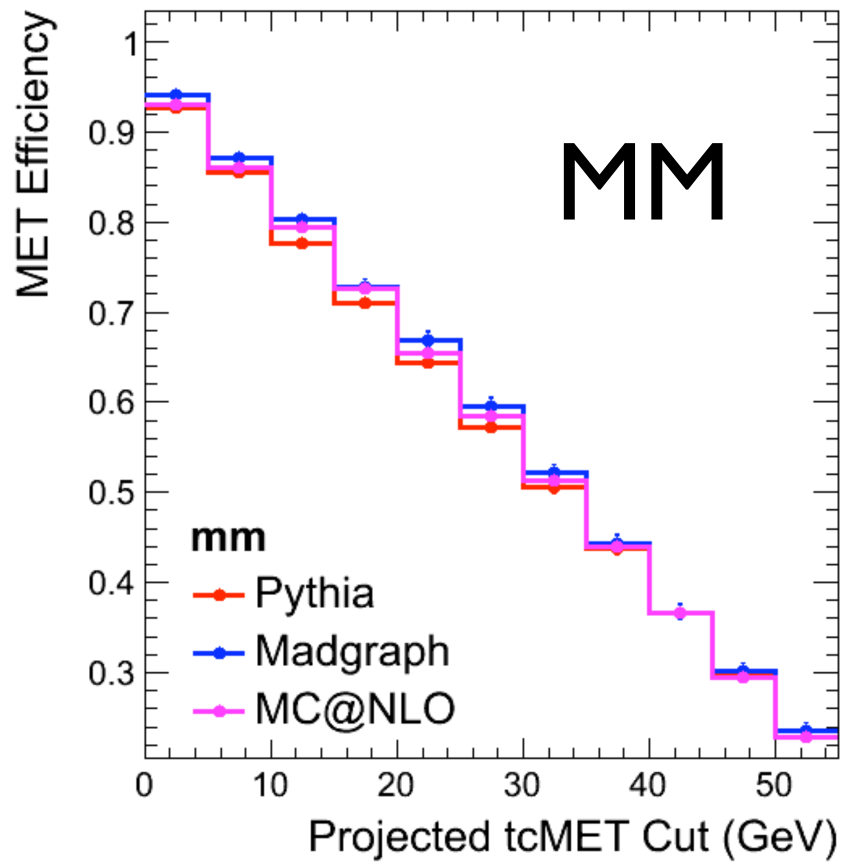
MET Signal Efficiency

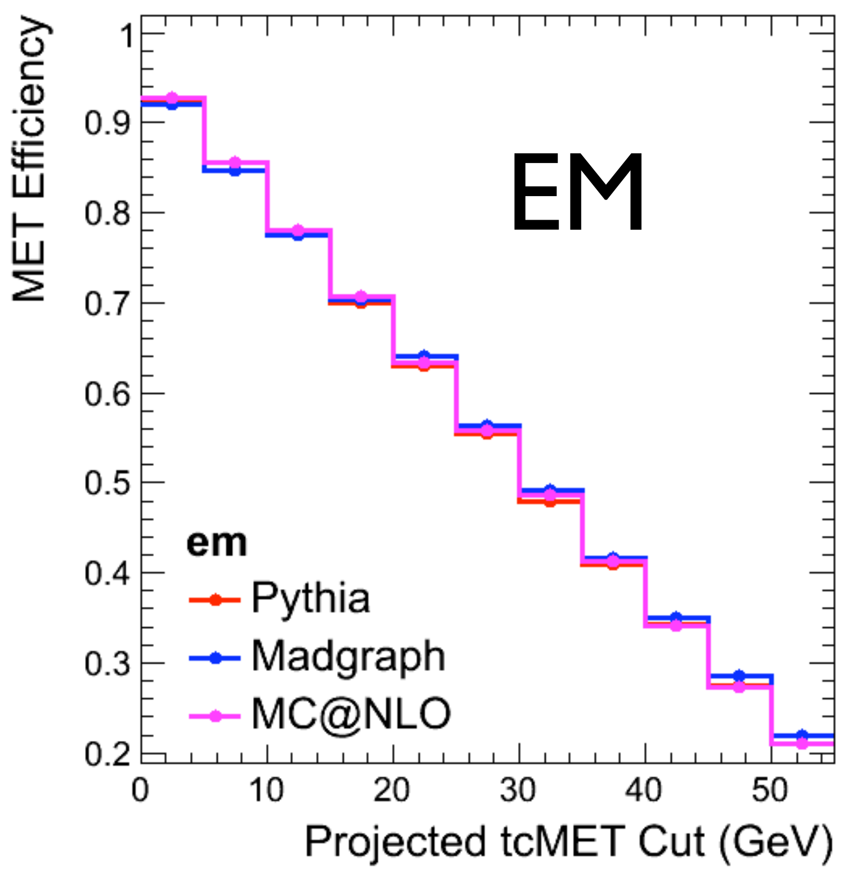
MET Selection Efficiency

- The current selection is based on the projected MET
  - EE/MM: projected MET > 35 GeV
  - EM: projected MET > 20 GeV
- We have to rely purely on the MC for this measurement
  - NLO and beyond effects
    - compare various MC samples
  - Data/MC MET resolution differences in Z-events
  - PU effect in the data
    - Embed WW MC with N random MET vectors from MinBias MC
    - MET efficiency vs N vertices, and see the effects

Met Efficiency from MCs



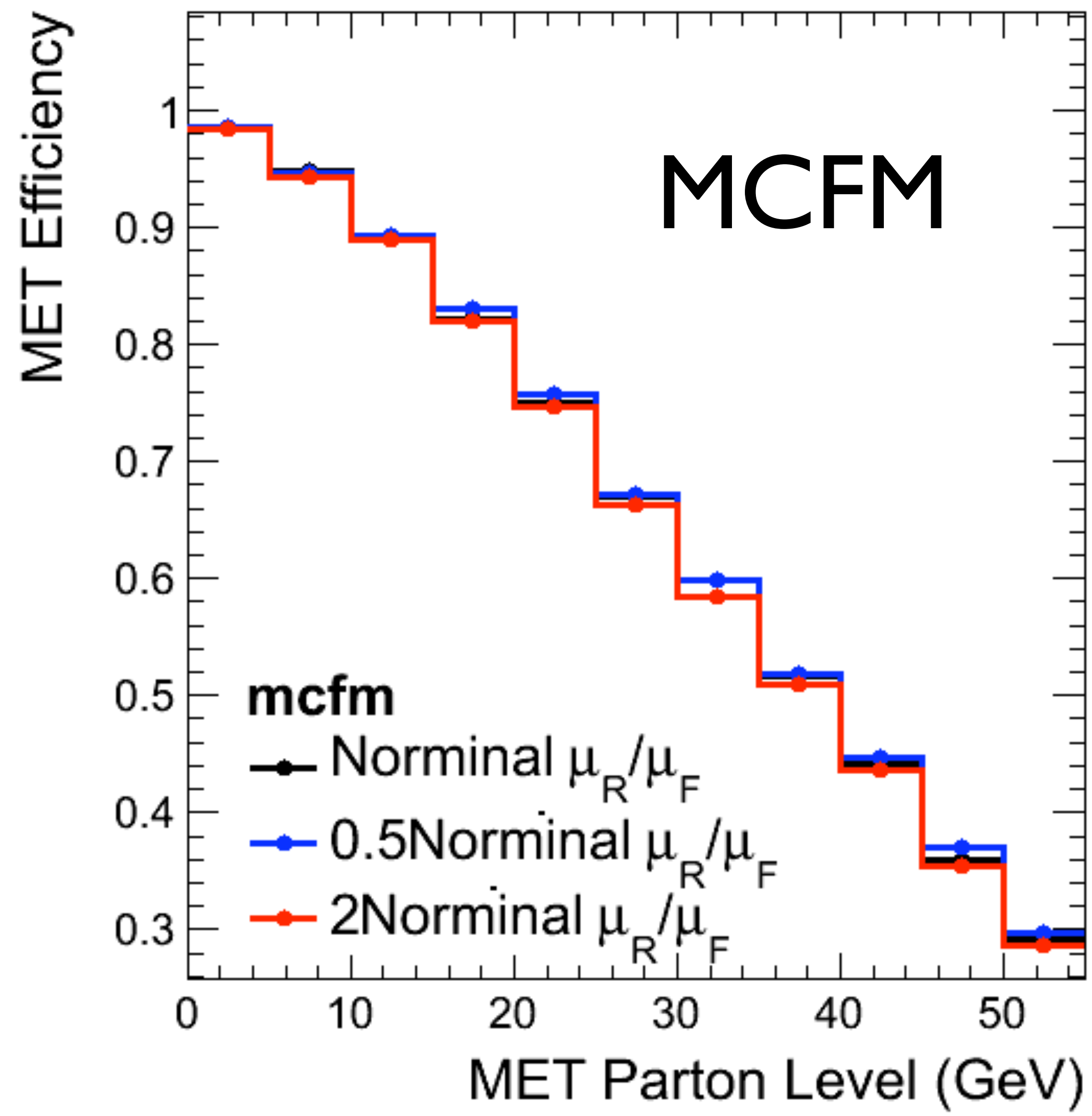




The largest relative difference between the 3 MC samples are 3% in MM, 1% in EE and EM with the reference V1 selections

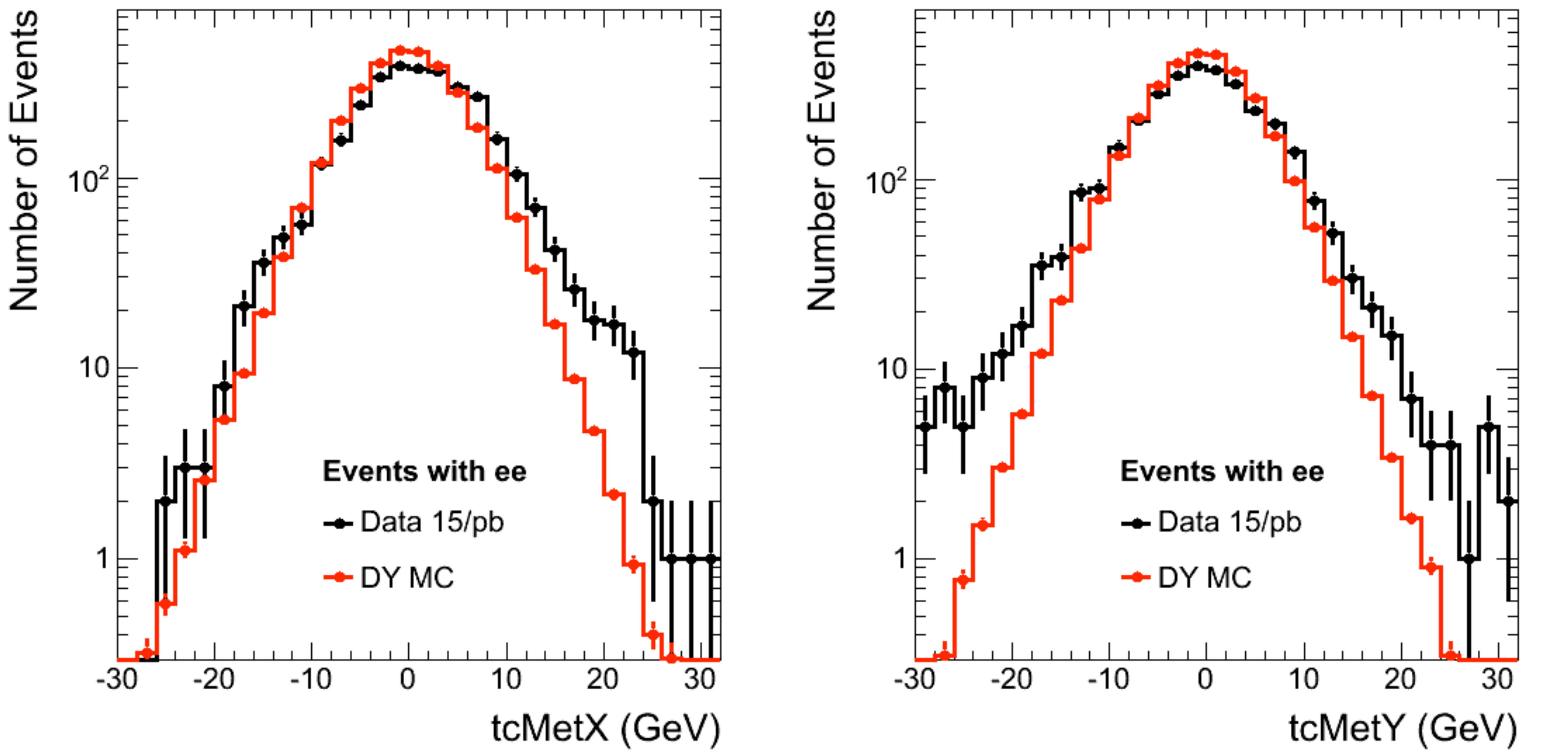
Met Efficiency from MCFM

- This is just a sanity check on the possible theoretical errors
  - The absolute number should not be directly compared with the values based on MC samples
  - Varying the normalization/ factorization scale gives only a hint on the NLO and beyond effects
  - The relative difference is 2% at 35 GeV



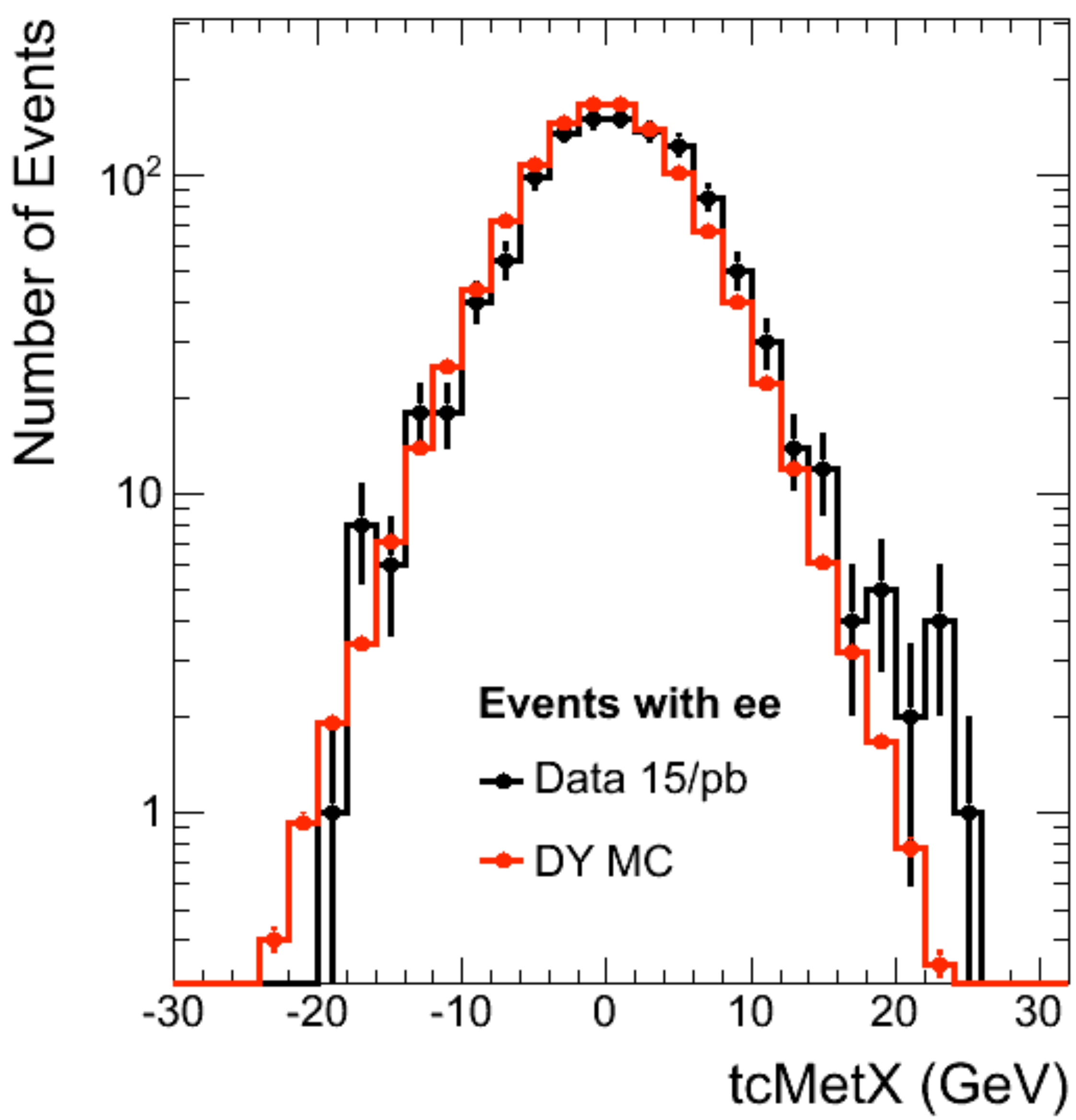
MET Resolution using Z Events

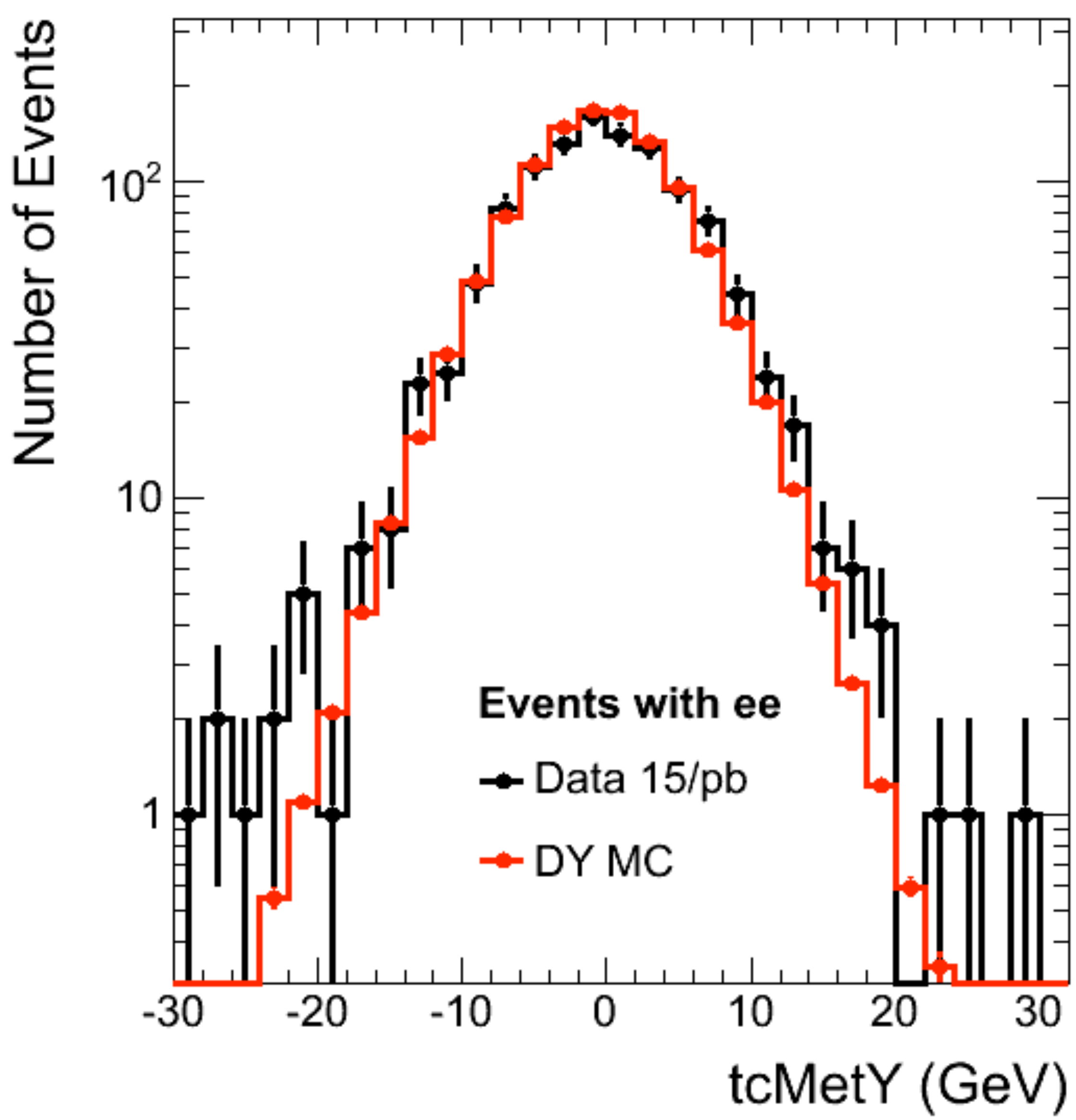
- The resolution in data is wider than in MC, mainly to the PU
  - The data/MC difference introduces more systematic error on MET eff.
  - The PU effects to Z events could be different from the effects on WW
  - $Z \rightarrow \mu\mu$ results are in backup slides 20-21



MET Resolution in One-Vertex Case

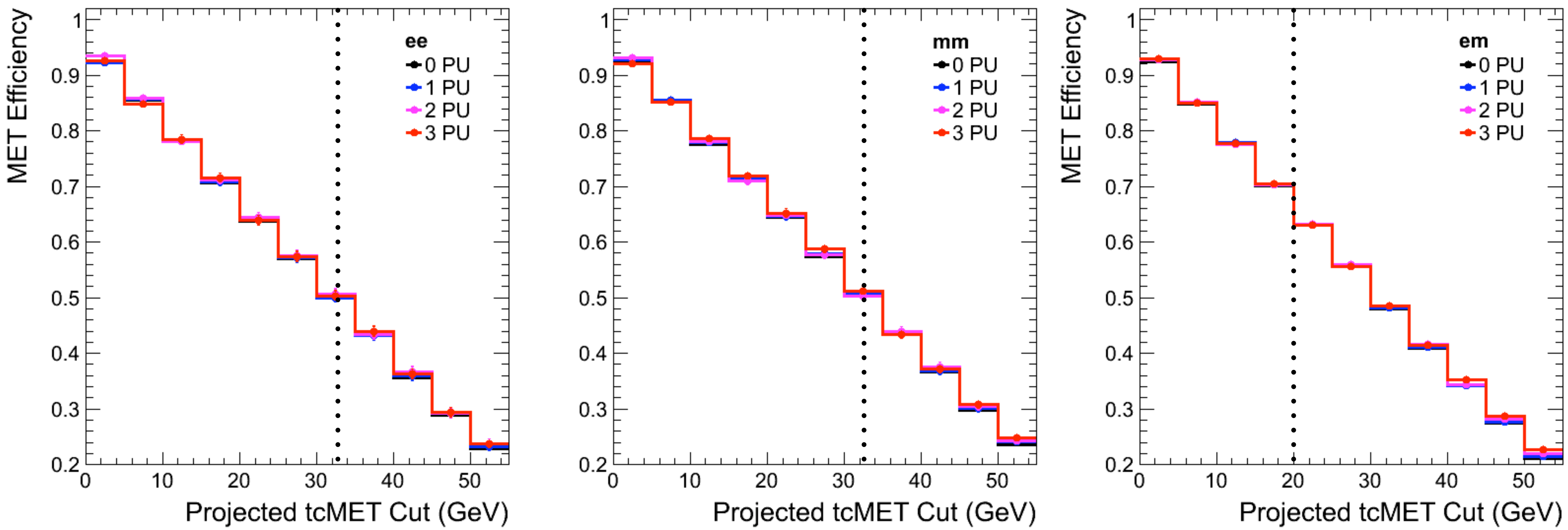
- Requiring only one good vertex in data
  - The resolution in data agrees much better with MC
  - PU effects are not negligible





Convolute MinBias MET with WW MC

- Convolute the WW MC MET with N MinBias MET
  - For each WW event, add N random MinBias MET vectors (x,y)
  - Recompute the projected MET
  - “Closure test” on the Z MET in slide 22

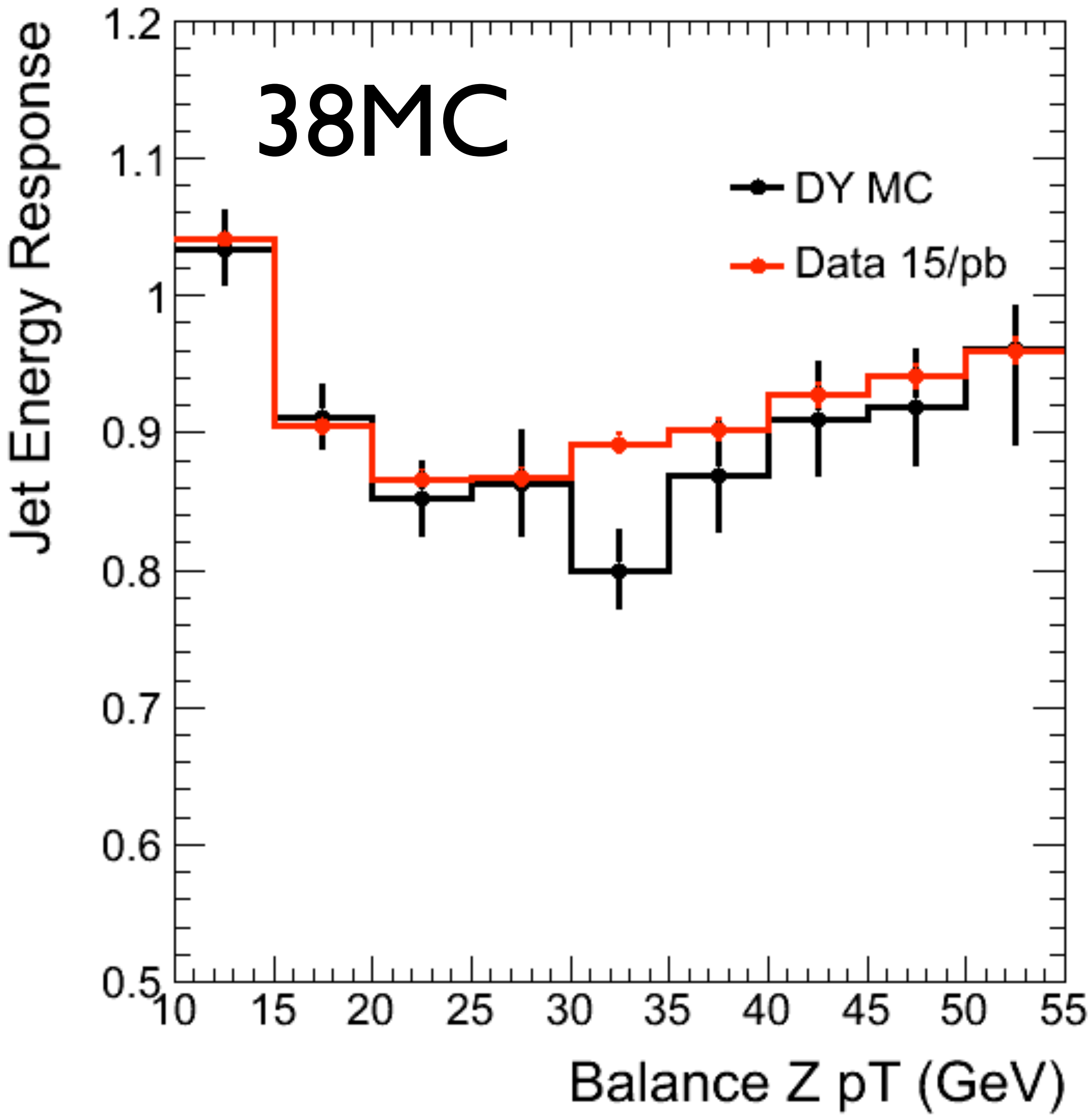


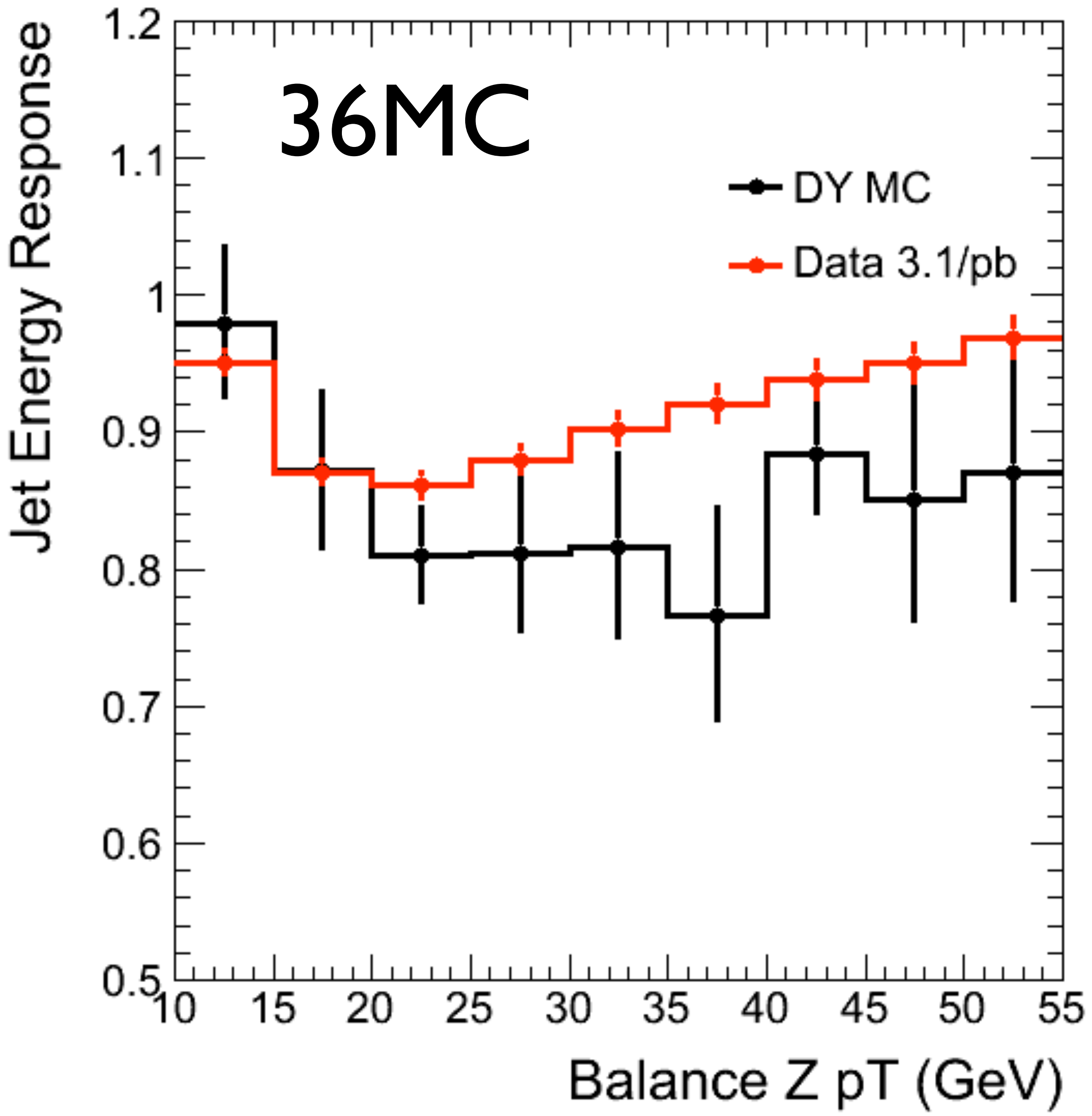
- The uncertainties due to the PU are negligible

JEC in 38X

JEC in 38X using Z + 1 Jet event

- JEC response: Corrected PFJet pT/ balance Z pT
  - Using 36X corrections on 38X data/MC gives good data/MC agreement
  - Event selections in backup slide 20





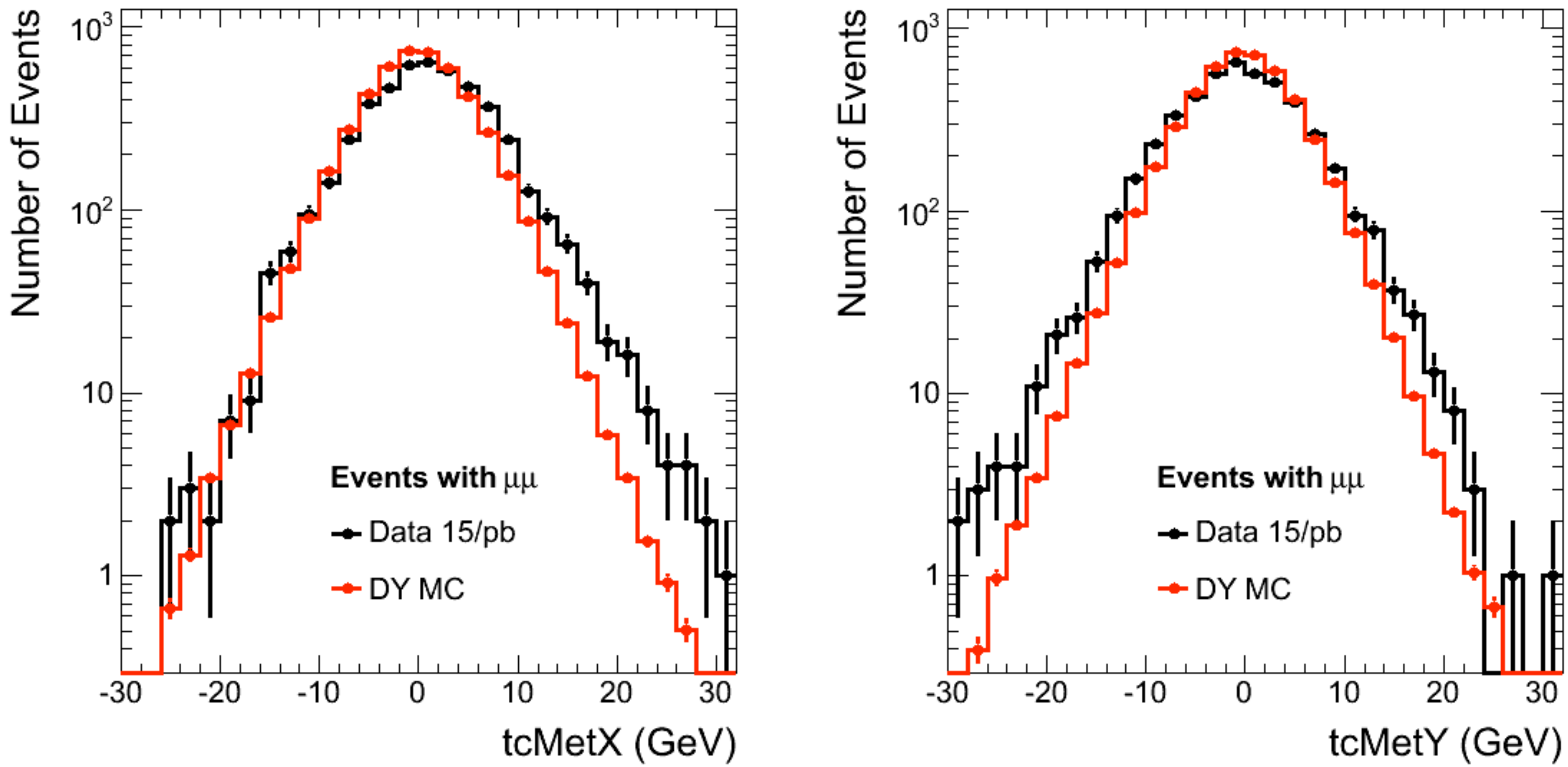
Summary

- DY estimation for WW: 0.0±0.0±0.0 (EE) 0.1±0.2±0.2 (MM)
  - The R(out/in) is sensitive to MET cut. We found that that mis-measured muons contribute largely to the events outside the Z window in MM. Add additional cut $\sigma pT/pT < 0.1$ on muons stabilize the R(out/in).
  - The $\sigma pT/pT < 0.1$ cut on muons reduces the DY in MM significantly, while the signal efficiency drop is < 0.5%. We propose to add this to V1.
- MET selection efficiencies on WW
  - Differences between Pythia/Madgraph/MC@NLO are within 3%
  - MET resolution (X,Y) are sensitive to the PU, seen in Z events
  - Convoluting WW signal with up to 3 PU shows that the effects are negligible for the MET efficiency
- Applying 36X corrections on 38X data/MC gives good data/MC agreement, using the L2/L3 PF Jets

Backup Slides

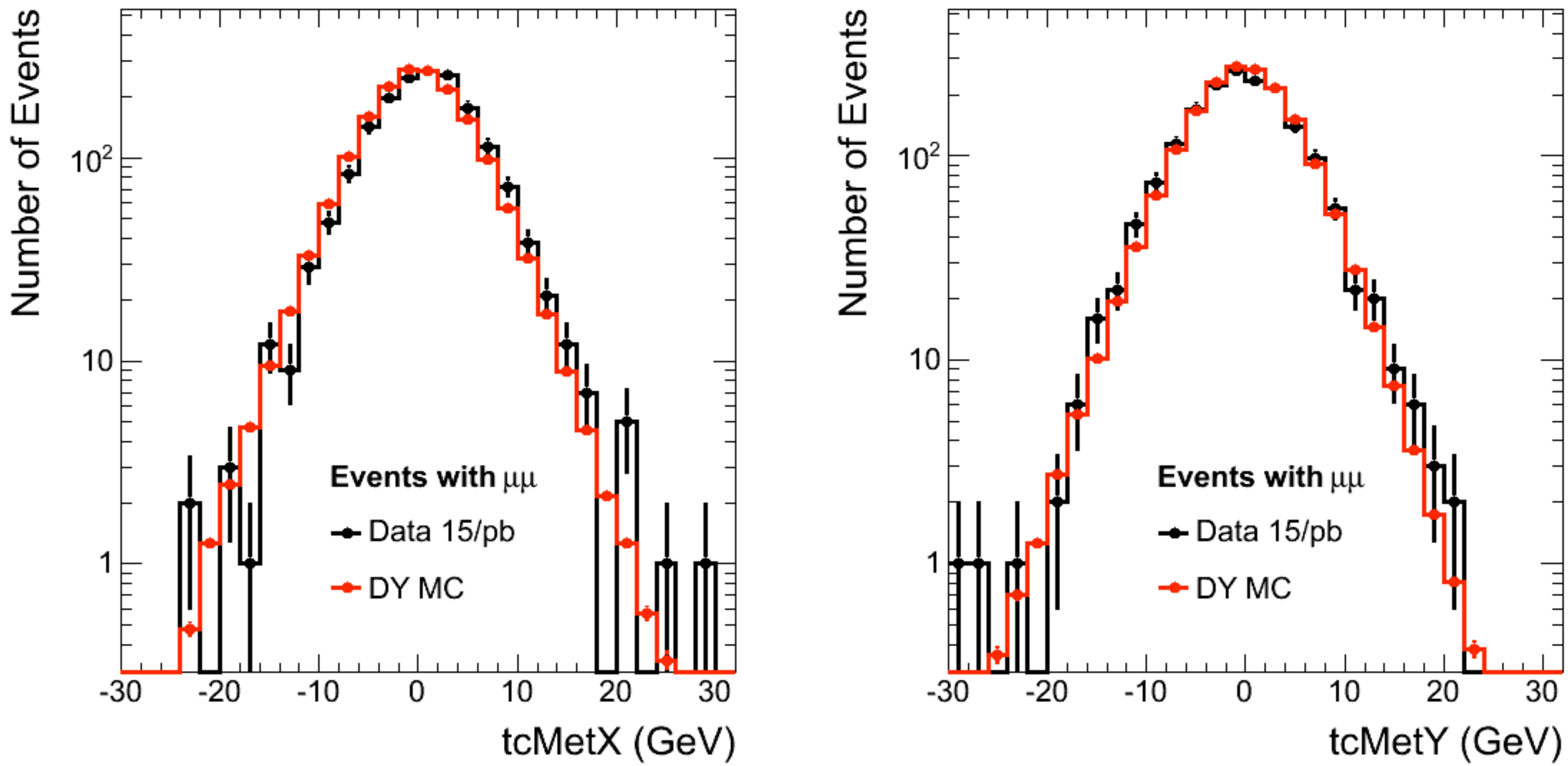
MET (x,y) in MM

- Events with all number of vertices



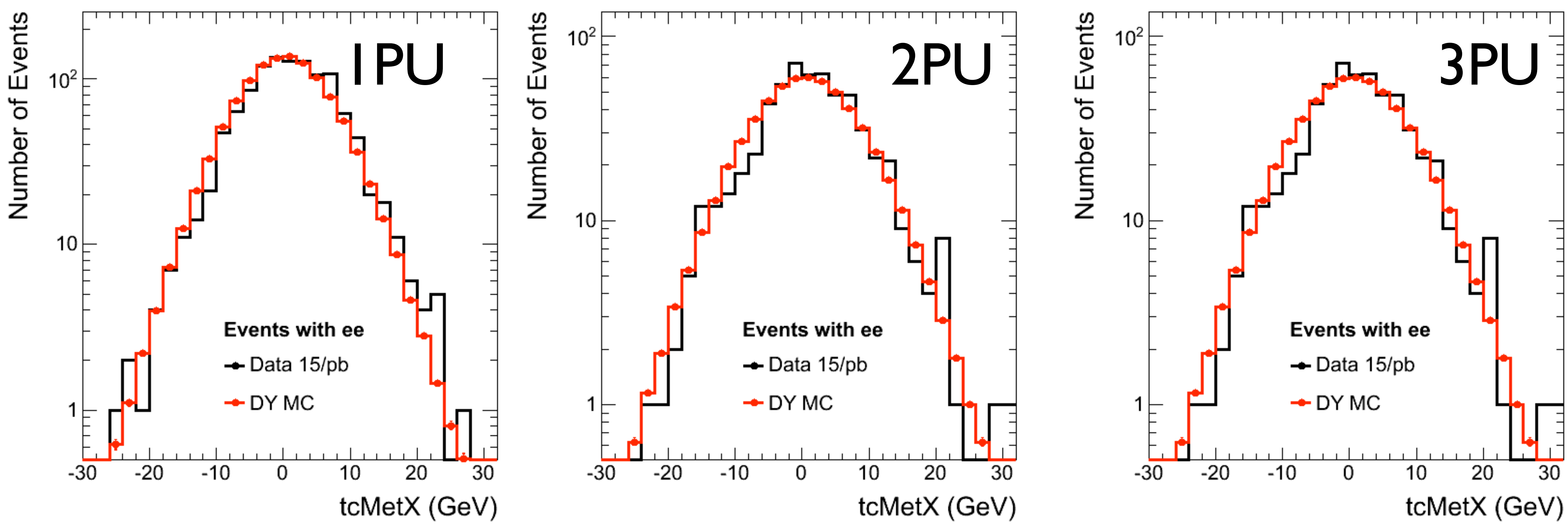
MET (x,y) in MM One-Vertex

- Require only one good vertex in Data



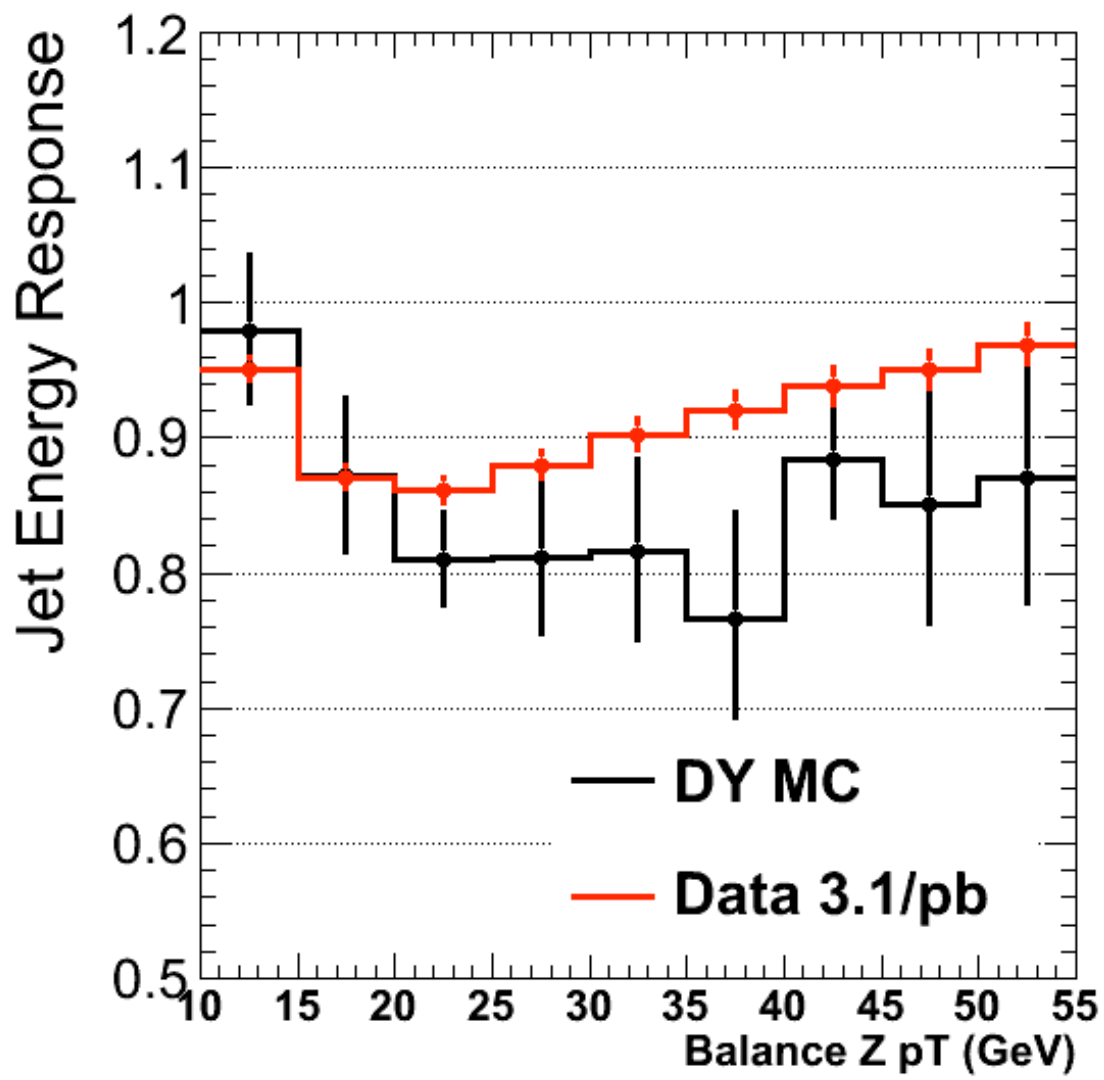
Closure Test of MinBias Embedding on Z

- Compare the Met (x,y) with PU between the data and the MinBias embedded Z MC
  - The width look consistent



Jet Energy Correction Using Z Balance (36X)

- The standard L2L3 JEC is derived for high pT jets, we need to cross-check the corrections in the region (20-30) GeV
- For this validation, we use Z+1 Jet events, with the selections,
  - $|\Delta\Phi(\text{leading jet-diLepton})-\pi|<0.2$
  - Other jets in the event with pT < 0.1 * leading jet pT
- The jet response is defined as corrected leading jet pT / dilepton pT



1. There is an overall systematic difference in data vs MC, however data is statistically limited

2. Similar conclusion is found from γJets study, Francesco Pandolfi http://indico.cern.ch/getFile.py/access?contribId=0&resId=0&materialId=slides&confId=108390

3. Assume the 7% at 25GeV is real, we get ~2-3% additional uncertainty from JEC, this needs to be checked with more data